Feeding and Nutrition

Modern fish feeds have evolved to be specific to the nutritional needs of a wide variety of species. The exact nutritional requirements for Gulf killifish are not known at this time; however, a few general assumptions can be made based on research completed to date. Additionally, information from nutritional studies of freshwater baitfish can help provide guideposts and general recommendations for Gulf killifish culture. The following is a summary of the issues related to Gulf killifish feeding and nutrition, with reference examples from published studies and personal observations, or from freshwater baitfish research when information specific to Gulf killifish is not available. This fact sheet serves as a basic summary of nutritional information for Gulf killifish culture. The type of culture system will influence whether diets are used as sources of supplemental nutrition, or to provide the complete nutritional needs of the fish.

In Ponds or Outdoor Systems

The natural productivity of a fertilized pond or outdoor tank will provide at least some nutritional value to cultured fish. Natural foods are inexpensive sources of nutrients to fish, but the quantity and quality available will be determined by following appropriate fertilization and monitoring regimes. Rotifers and other plankton in a newly fertilized pond make easy prey for newly hatched fish that are ready for first feeding. As fish grow, so does the preference for larger zooplankton like copepods, insect larvae, worms, and snails. The role of prepared diets becomes more important as the amount of natural food decreases due to high fish density or low natural production. Previous studies on Gulf killifish reared at low densities in ponds found similar growth in fertilized ponds with or without supplemental feed. It is unclear whether supplemental feeding in Gulf killifish ponds results in direct consumption, or just serves as an additional source of fertilizing nutrients to support natural food. However, in the more thoroughly studied freshwater baitfish industry, the use of modern manufactured feeds greatly increased baitfish production even when natural foods were present.

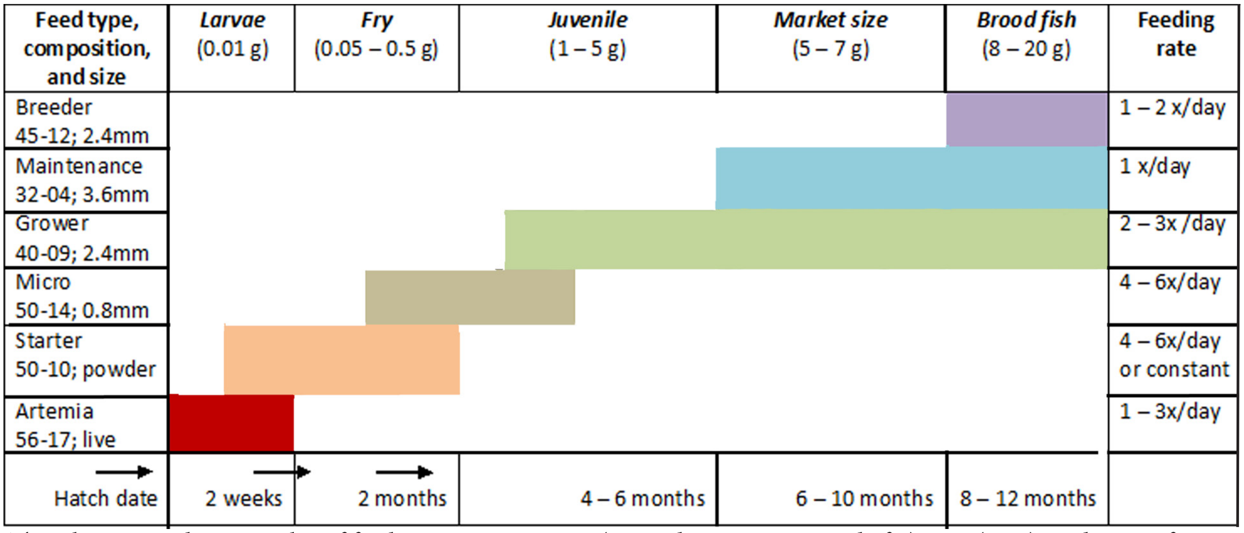
The need for, and role of, supplemental feeding in Gulf killifish pond or outdoor tank production will be tied directly to two factors: 1) density of fish stocked and 2) water temperature. When natural production is below the total nutritional demand of the biomass, then growth will be stunted if the system is not provided a supplemental diet. Seasonal variability also plays a role in outdoor production characteristics, as fish will eat more and grow faster when water temperature is warmer.

In Tanks or Indoor Systems

When Gulf killifish are cultured in indoor closed systems, all of the nutritional requirements for survival and growth must be provided by the diet. Using a nutritionally complete, high quality diet increases the efficiency of these intensive fish culture systems. The benefit of this type of system is the complete control over variables influencing growth. Temperatures can be maintained at ideal levels, oxygen or aeration is typically constant, and fish can be fed multiple times per day with the use of automatic feeders. The caution is that closed recirculation systems are limited by the capacity of the filtration system to remove the nitrogenous waste byproducts (ammonia, nitrite). Care should be taken to only feed fish an amount that will be consumed in a short period of time (20-30 minutes), as excess feeding can reduce water quality and is an expensive waste of feed.

Feeding Practices

The first nutrition derived by larval fish is provided by the yolk, which originates from the body, and thus diet, of female broodfish. Early hatching fish have large yolk volumes and will remain near the bottom of the tank. Once



This chart provides examples of feed type, composition (% crude protein-% crude fat), size (mm), and rates of feeding for various sizes of cocahoe minnows. Additionally, the chart estimates the length of time it would take to grow cocahoe minnows to each size class, and what the approximate weight (g) of individual fish at each class.

the yolk has been consumed, they begin exhibiting characteristics of swim-up fry, indicating readiness for first feeding. This can occur a few days after hatching, or shortly after hatching in the case of air-incubated embryos delayed past the normal hatch date. Brine shrimp are typically the first food offered, as they contain relatively high levels of nutrients and offer a moving live food that can benefit the predatory instincts of larval fish. After a few days of brine shrimp feeding, high quality powdered starter diets can be introduced, with a gradual total replacement. Recent studies have indicated some success in using commercially available starter diets to replace brine shrimp in the first stage of larval rearing.

As fish grow, diets can increase in size (proportionate to mouth gape) and decrease in nutrient levels and feeding rates. Feeding prepared diets that are appropriate in size helps to make feeding more efficient by maximizing the reward (nutritional intake) for the effort (energy spent feeding). Younger fish typically require higher nutrient levels that older fish. Nutrient levels can be reduced by feeding lower quality diets, or by simply feeding smaller amounts.

Feed Components

Prepared diets can be broken down into three major component categories: macronutrients (energy and protein), micronutrients (vitamins and minerals), and non-nutritive elements.

Protein

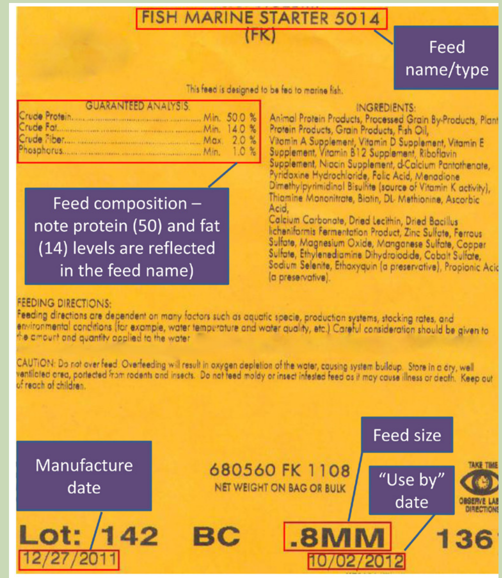
Protein is the most expensive part of fish feed, so care should be taken to select feeds with appropriate levels of protein. The protein requirement can change with age of fish, as younger fish generally need to be fed a high protein diet at regular intervals to maximize growth. As fish age, the protein requirements are reduced.

It is important to note that not all proteins are the same. This is because proteins are made of individual amino acids, which serve as the building blocks of a protein. Fish are unable to synthesize 10 of these amino acids, so they must be provided by the diet. Plant-based protein (soybean meal, cottonseed meal, etc.) are typically deficient in one or more of the essential amino acids. Animal-based protein (fishmeal, poultry meal, etc.) tend to have a better amino acid profile but are often more expensive than plant proteins. As a result, feeds are typically formulated on a least cost basis, which combines multiple sources of protein to achieve desired levels of specific amino acids.

Energy

Energy can be supplied by protein, fat, or carbohydrates. Fat is the preferred source of energy, because it is both cheap and energy-dense. Like protein, fats can come from plant or animal sources. Protein is a costly source of energy both financially and metabolically, so diets with sufficient energy should have the effect of sparing protein for growth. Carbohydrates are cheap sources of energy, but the digestive systems of most fish do not allow for complete breakdown and absorption of complex carbohydrates. Despite low digestibility, carbohydrates are useful as binders in commercially extruded, floating feeds.

While it is important for diets to provide enough energy to spare protein and maximize growth, there can be too much of a good thing. It is thought that fish eat to satisfy their energy needs. Energy is required primarily for basic metabolic demands, that is, to stay alive and function. After metabolic needs are met, then excess energy can be devoted to weight gain in the form of growth, protein accretion (building muscle), and fat deposition (stored energy). Diets with excessive energy can actually result in lowered feed intake and reduced weight gain. Diets high in fat are also at a higher risk of oxidative rancidity, which can ruin feed.



This typical example of a feed label shows protein content, fat content, pellet size and expiration date. This tilapia grower diet is an example of a feed that could be used for cocahoe growout.

Micronutrients

While needed at much lower levels, vitamins and minerals are essential for normal fish health and growth. Vitamins are either water-soluble (B and C) or fat-soluble (A, D, E, and K). The most important minerals are sodium, chloride, calcium, potassium, and phosphorus. It is also important to keep in mind that marine fish tend to have higher vitamin and mineral requirements than freshwater species.

Non-nutritive

Fiber is a common component in feeds, especially in plant-based diets, but it is virtually indigestible to fish. However, a small amount of fiber can actually promote digestion and absorption of other feed ingredients by helping to break apart feed materials in the digestive tract.

Water is another component in diets that provides no direct nutritional benefit. Its inclusion is usually the result of the feed manufacturing process (i.e. steam injection for extruded feeds). Most of the excess moisture is removed by drying feed, but some does remain. Moisture should be an important consideration for feed care and storage, because high moisture content promotes mold growth, which ruins feed. Care should be taken to store feed in a dry, cool location out of direct sunlight, as protein, fat, and vitamins are heat sensitive and can degrade at high temperatures. Only purchase as much feed as can be used before spoilage.

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